Effect of Preharvest Sprays of 2,4,5-Trichlorophenoxypropionic Acid Upon the Ripening of Jonathan, Starking, and Golden Delicious Apples

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CONTENTS

PAGE

TERMINOLOGY 3
- Morphology 3
- Maturation and Ripening 4
- Quality and Related Terms 4
- Condition 5
- Color 5
- Handling and Storage 6
- Composition 6

REVIEW OF LITERATURE 6
- Effects of NAA 6
- Effects of 2,4,5-TP 8

MATERIALS AND METHODS 9

RESULTS 10
- Observed Effects 10
- Measured Effects 11

EVALUATION OF RESULTS 25
- Effects of 2,4,5-TP on Apples Harvested When Immature 25
- Effects of 2,4,5-TP on Apples Harvested at or Near Maturity 27
- Effects of 2,4,5-TP on Apples Post-Ripened at 75° F 27

CONCLUSIONS AND RECOMMENDATIONS 29

LITERATURE CITED 29

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Effect of Preharvest Sprays of 2,4,5-Trichlorophenoxypropionic Acid Upon the Ripening of Jonathan, Starking, and Golden Delicious Apples

By Richard V. Lott and Robert R. Rice[a]

THE RIPENING RESPONSES of Jonathan, Starking, and Golden Delicious apples to preharvest sprays of 2,4,5-trichlorophenoxypropionic acid[b] are reported in this bulletin. The effects of 2,4,5-TP upon the maturation of these varieties were reported previously.[11]*

TERMINOLOGY

In spite of the obvious need for a standard terminology in technical publications dealing with fruit quality, terms are often inconsistently and ambiguously used. This is especially true of the terminology used to describe maturation and ripening, even though these processes are major considerations in any scientific discussion of fruit quality. To overcome this confusion, the Pomology division at the University of Illinois has adopted a specific terminology in regard to fruit quality. The terminology pertinent to this bulletin is defined below.

Morphology

The morphological terminology of Tukey and Young[17] for apples is usually followed. The pomological terms *skin* and *flesh* are added and defined as follows:

Skin — the externally visible part of the fruit; distinct from *peel,* which refers to the tissues removed in peeling.

Flesh — all the fruit tissues surrounded by epidermis except the cartilaginous pericarp and ovules (seeds).

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[b] Hereafter referred to as 2,4,5-TP.

* Superior figures refer to literature cited on page 29.

Maturation and Ripening

The terminology of maturation and ripening described in detail by Lott[6] is used. This terminology is based on the distinction between the preharvest and post-harvest environment of the fruit.

Maturation, mature, maturity — these terms and their modifications refer to the fruit *only* while it is still attached to the tree.

M1, M2, M3, M4 — designate progressive degrees of maturation, beginning with the least degree of maturation commonly harvested commercially (M1) and continuing to the *mature* fruit (M4). For example, the first commercial picking of Transparent apples in southern Illinois is made up almost entirely of M1 fruits. The meaning of M4 or mature fruit has been defined.[6] The fraction *0.5* added to a maturation symbol, as in M2.5, designates an intermediate stage between two degrees of maturation. An *M* number greater than *4* designates the degree of post-maturity.

Ripening, ripe, ripeness — these terms and their modifications refer to the fruit *only* after it is harvested.

Quality and Related Terms

Quality — degree of edible desirability; not used to refer to condition, even though the terms *quality* and *condition* are often used synonymously in horticultural literature, particularly in trade publications.

Acceptable quality — a degree of quality that, though not definitely undesirable, fails to stimulate a desire for repeated consumption.

Satisfactory quality — a degree of quality that stimulates a desire for repeated consumption.

Poor, fair, good, very good, excellent — used to rate the quality of a given sample of apples in comparison with the highest quality attained by apples. For example, the rating *excellent* can be given only to certain samples of a few varieties. Jonathans, for instance, that are well-grown and mature are rated *excellent*. Transparent apples, on the other hand, are rated only *good* at maturity; at the immature stage at which they are commonly harvested commercially, they are rated only *fair* or slightly higher. These terms when used in conjunction with the actual composition of the fruit become much more specific, and are used whenever they add to an understanding of the materials. *Very good* and *excellent* are the approximate equivalents of *satisfactory quality*. *Good* is the approximate equivalent of *acceptable quality*. *Very poor, poor,* and *fair* are the approximate equivalents of *unacceptable quality*.

Flavor — the psychological reaction to the combination of smell and taste in a food. In dealing with fruits, the term *aroma* is commonly used instead of smell because the aromatic compounds contribute most of the smell to normal fruits. However, undesirable smells may develop from rots, foreign odors, or the products of metabolism. The term *apple aroma* is used to designate the aroma common to the mature or ripe fruits of all varieties. At the same time, each variety has a characteristic aroma which is usually much more pronounced than the apple aroma. Of the four fundamental *tastes* — sweet, sour, bitter, and salt — only the sweet taste of sugars and the sour taste of acids are common in apples, though a bitter taste sometimes occurs. Consequently, flavor in apples is nearly always a combination of aromatic compounds, sugars, and acids. For detailed explanations of flavor see Crocker[2] and Moncrieff.[12]

Texture — the physical reaction or "feel" as fruits are chewed. In apples, such terms as hard, firm, crisp, mealy, juicy, and dry are used to describe texture.

Keepability — replaces the common term *keeping quality* to allow quality to retain a specific meaning, and signifies the degree to which any lot of fruit retains the potential quality that it had at harvest when placed in a specific storage environment, or, conversely, the rate at which it loses its potential harvest quality in a given environment.

Condition

Condition is a phenomenon separate and distinct from quality. It is concerned with freedom from and incidence of such defects as those resulting from insects, diseases, russeting, handling, and storage disorders.

Color

Background or background color — refers to the green and yellow colors and their combinations found in the skin or peel of apples. These terms replace the commonly used term *ground color* which is neither specific nor expressive of the situations encountered.

Overlying color — refers to the red colors and their modifications in conjunction with a background color.

Amount — the proportion of apple surface covered with the red color characteristic of the mature fruits of a given variety.

Intensity — the amount of red or yellow pigment per unit area of surface. *Redder* and *reddest* refer to increasing intensity of red pigment; *yellower* and *yellowest* refer to the increasing predominance of yellow over green in background color.

Flesh color — refers to color of edible tissues within the peel. It is measured near the radial center of the cortex unless otherwise stated.

Handling and Storage

Handling — any movement of the fruit from harvesting to consumption; includes picking, packing, transporting, storing, distributing, retailing, and handling by the consumer.

Storage — the environment during the *ripening* life of the apple. As soon as the fruit is separated from the tree, it is in some sort of storage environment, ranging from the environment in which the fruit is merely lying on the ground under the tree to that in special structures in which there is control of one or more of the environmental factors.

Composition

For a complete understanding of the physiological changes occurring in apples during development and senescence, the concentration of the constituents of the fruit must be expressed in amount per apple as well as in percent.

Percent or percentage — the grams of a constituent per 100 grams of material, either fresh or dry. The fresh-weight percentage is used most frequently.

Amount — the grams of a constituent in an individual apple.

Content — refers to either percent or amount in those cases in which either term is expressive of the physiological situation.

Concentration — has the same meaning as *content,* but is used most often to refer to percent.

REVIEW OF LITERATURE

Only publications containing information about the effect of naphthaleneacetic acid[a] and 2,4,5-TP upon the ripening of fall-maturing varieties are considered here, since they are the only preharvest sprays that have been widely used and extensively investigated.

Effects of NAA

What appears to have been the first investigation of the effects of NAA sprays upon the ripening of fall-maturing varieties was made by Roberts.[13] In 1940 he made two pickings of sprayed and unsprayed

[a] Hereafter referred to as NAA.

Jonathan, Grimes, and Winesap apples, the first when the apples were nearly mature, the second, 2 weeks later. He concluded, after storing the apples at 32° F. and sampling and comparing them at intervals until they were ripe, that NAA affected neither the rate of softening, the sugar and acid content of the juice, nor the quality of these varieties.

Haller[5] stored Jonathan, Delicious, Starking, Rome Beauty, Stayman Winesap, and York Imperial apples that had been sprayed with NAA. Comparing them with check fruits picked at the same time, he concluded that NAA had no direct effect on firmness, development of decay, breakdown, or scald. Whether NAA affected Jonathan spot or shrivel was not determined. His picking dates indicate that he used both immature and mature apples for all these varieties except Delicious, although this was not mentioned.

Batjer and Moon,[1] who used multiple sprays of NAA on Jonathan, Delicious, and Rome Beauty — four applications on Jonathan, five on Delicious, and six on Rome Beauty — stored the apples at 31° F. for approximately 100 days, then stored them for an additional 7 days at 70° F. They concluded that NAA did not affect the keepability of any of these varieties.

Gerhardt and Allmendinger reported[4] that an application of NAA to Winesap and Delicious had no influence on the keepability of either variety, except when Delicious became post-mature before harvest.

Smock and Gross,[14] who in three different years sprayed NAA on individual limbs of McIntosh trees and used respiration measurements at 74° F. during the 7 days following harvest to determine the ripening rate of the apples, reported variable results. In 1941 they found that NAA at a concentration of 10 p.p.m. (parts per million) had no effect on respiration rate in the apples of three pickings made 14, 21, and 28 days after spraying. In 1944 the same treatment was applied to McIntosh and the apples picked at four different times. NAA increased the respiration rate of the apples in the first and second pickings only slightly, markedly stimulated the rate in the third picking, and did not affect the rate of respiration in the apples of the fourth picking, which were considered to be post-climacteric. In 1946 these investigators applied the sodium salt of NAA to individual McIntosh limbs at concentrations of 10 and 20 p.p.m. Both concentrations had a marked effect on the respiration rate in the apples of the first picking made 5 days after spraying. In the apples of the second picking, which was made 8 days after spraying, the 20 p.p.m. treatment increased the respiration rate markedly, but "not enough apples remained on the 10 p.p.m. sprayed limb for a respiration sample."

In none of these reports was the date of maturity specified. Had the degree of maturation of each of the samples been given, interpretation of the results would have been greatly facilitated.

Lott[7] made three applications of NAA at 10 p.p.m. to Jonathan, then stored samples of treated and check fruits at 32° F. The first samples were picked 15 days before maturity, the second at maturity, and the third and fourth at 13 and 39 days after maturity respectively. Samples examined at certain intervals during ripening and post-ripening showed no significant differences between check and treated fruits in quality, rate of weight loss, or in the percentages of sugars, acid, and dry matter.

From these various reports, it appears that among the fall-maturing varieties, only those of the McIntosh type are likely to decrease in keepability as a result of NAA applied at the normal concentration of 10 p.p.m., if the apples are harvested before they become post-mature.

Effects of 2,4,5-TP

The effects of 2,4,5-TP upon the ripening of apples in southwestern Michigan were observed by Davidson,[3] who used pressure tests as the measure of ripeness. He reported that 2,4,5-TP did not affect the rate of softening in McIntosh apples grown in two different orchards. A single application of 2,4,5-TP to Starking apples at 20 p.p.m. 6 weeks before they were harvested resulted in slightly softer fruit after 3 months of storage at 33° F. The same treatment applied to the same variety 17 days before the apples were harvested did not affect firmness at the end of 3 months of storage at 33° F. Single and double applications of 2,4,5-TP to Baldwin had no apparent effect on firmness during 4 months of storage at 32° F.

Smock *et al.*[15] applied 2,4,5-TP at 20 p.p.m. to Early McIntosh and McIntosh and measured the respiration rate at 70° F. during the 8 days following picking. In Early McIntosh picked 11 days after treatment the spray "resulted in significantly more total carbon dioxide being evolved during the 8-day experiment." In McIntosh apples picked 14 and 24 days after the application of 2,4,5-TP the amount of evolved carbon dioxide was greater from the treated than from the check fruits. The degree of maturation of these samples at harvest was not given, nor were statements made regarding the quality and condition of these apples at the completion of the ripening process — points that would have made these results more understandable.

Southwick *et al.*[16] applied 2,4,5-TP to McIntosh apples, picked them 12 days later, and measured their respiration rate at 74° F. during the first 8 days after harvest. They reported that "It is apparent that 20 p.p.m. of 2,4,5-TP hastened the rate of respiration, whereas 10 p.p.m. of the same material seemed to have no effect." Though the degree of maturation was not stated, the data indicate that the apples at harvest were near the beginning of their climacteric rise.

The same investigators applied 2,4,5-TP at 20 p.p.m. to McIntosh in two other orchards. They reported that the treated apples were less

firm than check fruits at harvest, and that this difference in texture persisted throughout 3½ months of storage at 32° F. Their data did not indicate any increase in the rate of softening.

Lott[8] found that in 1951 at Urbana, Illinois, Cortland, Golden Delicious, Grimes Golden, McIntosh, and Solid Red McIntosh apples that had been sprayed with 2,4,5-TP at 20 p.p.m. broke down faster during ripening than check fruits. Varieties whose keepability was not affected to any commercially important extent included Jonathan, Jonared, Delicious, Starking, Red Rome, Gallia, and Turley.

Another study by Lott,[9] conducted in 1953 when the maturation season was unusually hot and dry, showed that 2,4,5-TP, applied twice to Jonathan, Delicious, Starking, Winesap, and Stayman at 20 p.p.m. 4 and 2 weeks before maturity, did not significantly reduce keepability in any of these varieties except Stayman, whose rate of breakdown increased to an economically important extent.

From these various investigations, it appears that an increased rate of ripening from 2,4,5-TP is most likely to occur in those varieties that are similar in physiological make-up to McIntosh and that receive the 20 p.p.m. application. No increase in rate of ripening from 2,4,5-TP has been reported for other fall-maturing varieties except Golden Delicious, Grimes Golden, and Stayman.

MATERIALS AND METHODS

Details concerning the choice of trees, the application of 2,4,5-TP, the selection of samples, and the methods used for the physical and chemical determinations have been described in a previous bulletin.[11] Only the method of handling the stored samples remains to be explained here.

On each of the dates given in the *date sampled* column of the tables, the check and treated samples,[a] each consisting of 24 fruits, were removed from storage. Each apple was first weighed to determine its weight loss in storage and its condition recorded. Then one treated sample of each variety, together with a corresponding check sample, was used for pressure tests, after which it was cut up for the determination of dry matter, soluble solids, and acidity. The remaining samples were then returned to storage until the next sample date. On the next-to-last sample date, one of the two remaining samples of each variety was worked up as usual, but the second, used on the final

[a] The samples collected on September 11 were untreated. The "check" samples were taken from those trees reserved for checks; the "treated" from those to which 2,4,5-TP at 20 p.p.m. was applied later in the day and again at 20 p.p.m. on September 25. These samples were kept separate at this time to compare the differences in the fruit before treatment in order to determine what subsequent differences were caused by 2,4,5-TP.

sample date, was stored at 75° F. for 7 days to simulate retail-market conditions before it was worked up.

An explanation of why certain dates were selected for sampling is now in order:

1. The first sample date, which fell 42 days after each sample of each variety was picked, was chosen because previous experience had shown that ripening changes were definitely measurable at that time.

2. The second sample date was chosen because the fruits of each sample were then most likely to be at their highest quality.

3. The third sample date was chosen because by then each sample of each variety was likely to be definitely post-ripe.

4. The fourth sample date, which fell 7 days after the third sample date, was chosen in order to keep one sample of each sample group at 75° F. for a week.

Had personnel and material been available, a sample in each sample group would have been post-ripened at 75° F. for 7 days at each sample date. Since this was not possible, the last sample in each sample group was chosen for post-ripening at this temperature. Previous work had shown that the greatest effect would occur in samples post-ripened late in the storage season and that, consequently, the maximum difference between check and treated samples would be shown by these samples.

RESULTS

Most of the measured effects are shown in the tables and discussed below. Certain effects that could not be satisfactorily measured are also presented here on an observational basis. Because of the large number of samples involved in this investigation, the discussion is limited to salient points.

Observed Effects

Jonathan. The quality of the check and treated sample groups picked September 11 and September 18 failed to increase very much during ripening. All these samples remained deficient in apple and varietal flavor throughout storage. Although the September 18 sample group ranked slightly higher than the September 11 sample group, the quality of both groups was unacceptable.

The sample group picked September 25 — check and treated alike — ripened to barely acceptable quality. Texture in this group, like that in the earlier groups, became progressively less firm and less juicy in storage.

The sample groups picked October 2 and October 9 were the only ones that ripened to satisfactory quality. The slightly higher quality that the check fruits had at harvest persisted throughout ripening.

Starking. There was no difference in quality between check and treated fruits in the ripened samples of the first three sample groups. The sample groups picked September 11 and September 18 ripened to poor-to-fair quality, and no sample in either group was acceptable. All these samples retained an immature flavor and were somewhat astringent. The quality of the samples of the group picked September 25 was quite similar to the quality of the sample groups picked earlier, except that the quality of this group improved slightly during ripening.

Only the sample groups picked October 2 and 9 ripened to satisfactory quality. The differences in quality at harvest between check and treated fruits of these groups continued during ripening, with the checks having noticeably higher apple and varietal flavor as well as firmer texture. These differences, though not of commercial importance, were easily detected.

Golden Delicious. The check and treated sample groups picked September 11, 18, and 25 ripened to unacceptable quality because they lacked crispness, juiciness, and varietal flavor. The slight differences in quality that existed among these groups were attributable to picking date: those picked earliest were poorest.

The sample group picked October 2 ripened to acceptable quality, but the check fruits rated higher in quality because they were firmer, juicier, and had more abundant varietal flavor. The longer the check and treated samples in this group ripened, the greater became the difference between them.

Check fruits in the sample groups picked October 9 and October 16 ripened to acceptable quality, but the treated fruits in these groups had barely acceptable quality at best, and that quality decreased as the storage interval increased. The differences between check and treated fruits in these two groups were quite distinct and of definite commercial importance.

Regardless of variety, the quality of each of the samples that was ripened for 7 days at 75° F. deteriorated rapidly as compared with the preceding sample of its group. Decline in quality was associated with softer texture, deficient aroma, lower acid percentage, and a generally lower sucrose content.

Measured Effects

Condition

Table 1 shows the most important changes in condition during the ripening of these three varieties.

Jonathan spot. By January 15, when the Jonathan samples reached their maximum quality, there was no consistent difference in the percentage of spot between check and treated samples in any of the sample

Table 1.—Effect of 2,4,5-TP Upon Condition of Jonathan, Starking, and Golden Delicious During Ripening, 1951 Crop

Date picked	Degree of maturation at harvest	Date sampled	Percent of Jonathan spot— Check	Percent of Jonathan spot— Treated
Jonathan				
Sept. 11[a]		Oct. 23	3	0
		Jan. 15	4	0
	M1.0	Mar. 4	2	6
		Mar. 11	4	8
Sept. 18		Oct. 30	0	0
		Jan. 15	1	3
	M2.0	Mar. 4	13	8
		Mar. 11	21	13
Sept. 25		Nov. 6	5	13
		Jan. 15	14	18
	M3.0	Mar. 4	29	38
		Mar. 11	33	58
Oct. 2		Nov. 13	27	23
		Jan. 15	42	47
	M4.0	Mar. 4	50	77
		Mar. 11	46	79
Oct. 9		Nov. 20	7	6
		Jan. 15	11	18
	M4.5	Mar. 4	29	60
		Mar. 11	29	88
Oct. 16[b]		.....	..	..
		.....	..	..
.....		.....	..	..
		.....	..	..

Degree of maturation at harvest	Date sampled	Percent of scald Check	Percent of scald Treated
Starking			
	Oct. 23	6	0
M1.0	Jan. 24	33	36
	Mar. 25	90	92
	Apr. 1	96	96
	Oct. 30	0	0
M2.0	Jan. 24	13	14
	Mar. 25	69	79
	Apr. 1	79	83
	Nov. 6	0	0
M3.0	Jan. 24	0	0
	Mar. 25	14	12
	Apr. 1	33	24
	Nov. 13	0	0
M4.0	Jan. 24	0	0
	Mar. 25	0	0
	Apr. 1	0	0
	Nov. 20	0	0
M4.5	Jan. 24	0	0
	Mar. 25	0	0
	Apr. 1	0	0
.....	.....	..	..
	.....	..	..
	.....	..	..
	.....	..	..

Degree of maturation at harvest	Date sampled	Percent of shrivel at each degree— Light Check	Light Treated	Moderate Check	Moderate Treated	Severe Check	Severe Treated
Golden Delicious							
	Oct. 23	6	3	0	0	0	0
M1.0	Dec. 11	22	3	11	0	0	0
	Feb. 12	38	48	29	29	2	0
	Feb. 19	46	54	42	38	8	8
	Oct. 30	0	0	0	0	0	0
M2.0	Dec. 11	14	11	1	0	0	0
	Feb. 12	52	25	15	38	0	0
	Feb. 19	46	38	38	46	4	8
	Nov. 6	0	0	0	0	0	0
M3.0	Dec. 11	3	7	0	0	0	0
	Feb. 12	42	27	17	27	0	2
	Feb. 19	54	29	25	29	13	13
	Nov. 13	0	0	0	0	0	0
M3.5	Dec. 11	1	10	0	3	0	0
	Feb. 12	42	31	4	31	0	8
	Feb. 19	63	38	29	21	0	38
	Nov. 20	0	12	0	6	0	0
M4.0	Dec. 11	0	14	0	10	0	3
	Feb. 12	40	21	0	33	0	10
	Feb. 19	52	33	43	29	0	24
	Nov. 27	0	29	0	17	0	1
M4.5	Dec. 11	2	37	0	17	0	3
	Feb. 12	38	14	19	31	0	36
	Feb. 19	29	10	62	19	5	67

[a] The samples collected on this date were untreated. The "check" samples were taken from those trees reserved for checks; the "treated" from those to which 2,4,5-TP was applied later in the day and again on September 25. These samples were kept separate at this time to compare the differences in the fruit before treatment in order to determine what subsequent differences were caused by 2,4,5-TP.

[b] Sampling was completed on Jonathan and Starking on October 9.

groups. By March 4 and March 11, treated samples of the mature and post-mature Jonathans picked October 2 and October 9 respectively showed significantly higher percentages of spot than the checks. This indicates that 2,4,5-TP has at least the potentiality of inducing the development of Jonathan spot, particularly as the fruits progress into post-ripeness. Additional evidence of this potentiality is the fact that many of the treated fruits had larger and more numerous spots than the check fruits.

Scald. Scald, though present on a few Jonathans in the sample groups picked September 11 and September 18, was not prevalent enough to justify including data on it in the table.

2,4,5-TP had no apparent effect on the development of scald in Starking. The high incidence of scald in both the check and treated samples in the first three sample groups is quite similar to that usually encountered in Starking apples picked at these stages of immaturity.

There was no scald on any of the samples of Golden Delicious, a variety that seldom if ever develops scald.

Shrivel. Shrivel was present only in Golden Delicious. Percentages for three degrees of shrivel — light, moderate, and severe — are shown in Table 1. That 2,4,5-TP induced the development of shrivel is shown by the fact that most of the treated samples in the sample groups picked October 2, 9, and 16 had higher percentages of moderate and severe shrivel than check samples. On December 11, when the fruits in these three sample groups had reached maximum quality, the treated samples generally had higher percentages of moderate and severe shrivel than the check samples.

The generally high percentages of shrivel in both the check and treated samples picked September 11, 18, and 25 are usual for stored Golden Delicious apples picked at these degrees of immaturity.

Firmness

The average resistance to pressure of the fruits in each sample is given in Table 2. Though the data show only slight difference between check and treated fruits in both Jonathan and Starking, organoleptic tests showed that the treated fruits in all ripened samples of the mature and post-mature Jonathan and Starking sample groups were definitely less firm and less crisp than the check fruits.

In Golden Delicious, as shown by organoleptic tests, the treated fruits in the three sample groups picked October 2, October 9, and October 16 were, when ripened, consistently softer than the check fruits. The softer texture that the treated fruits of these three groups had at harvest became accentuated in storage. This fact is not always shown by the pressure data because the texture of treated Golden Delicious, which was spongier on account of more severe shrivel,

Table 2.—Effect of 2,4,5-TP Upon Firmness of Jonathan, Starking, and Golden Delicious During Ripening, 1951 Crop

Date picked	Degree of maturation at harvest	Date sampled	Average pressure in pounds	
			Check	Treated
Jonathan				
Sept. 11[a]		Sept. 11	17.1	17.8
		Oct. 23	16.3	16.1
	M1.0	Jan. 15	11.0	11.0
		Mar. 4	10.7	10.4
		Mar. 11	9.6	8.8
Sept. 18		Sept. 18	16.3	16.6
		Oct. 30	15.2	15.1
	M2.0	Jan. 15	11.1	10.8
		Mar. 4	10.6	10.2
		Mar. 11	9.7	9.5
Sept. 25		Sept. 25	16.5	16.2
		Nov. 6	14.8	13.9
	M3.0	Jan. 15	9.9	10.2
		Mar. 4	10.0	9.7
		Mar. 11	10.4	10.3
Oct. 2		Oct. 2	15.9	15.5
		Nov. 13	12.5	12.4
	M4.0	Jan. 15	9.2	8.8
		Mar. 4	10.5	10.0
		Mar. 11	10.3	10.0
Oct. 9		Oct. 9	13.5	13.6
		Nov. 20	12.4	12.9
	M4.5	Jan. 15	10.2	10.3
		Mar. 4	10.6	10.8
		Mar. 11	11.0	10.6
Oct. 16[b]		.....	....	....
		.....	....	....
.....		.....	....	....
		.....	....	....
		.....	....	....

Degree of maturation at harvest	Date sampled	Average pressure in pounds	
		Check	Treated
Starking			
	Sept. 11	17.6	19.2
	Oct. 23	16.9	17.4
M1.0	Jan. 22	15.6	15.1
	Mar. 25	14.7	14.3
	Apr. 1	14.9	13.8
	Sept. 18	17.1	16.5
	Oct. 30	15.8	15.7
M2.0	Jan. 22	14.1	13.7
	Mar. 25	13.7	13.5
	Apr. 1	13.5	13.6
	Sept. 25	17.7	17.0
	Nov. 6	15.4	15.4
M3.0	Jan. 22	11.7	11.7
	Mar. 25	12.7	12.2
	Apr. 1	12.2	11.3
	Oct. 2	16.4	16.2
	Nov. 13	13.9	13.3
M4.0	Jan. 22	9.8	9.5
	Mar. 25	11.1	10.1
	Apr. 1	10.0	9.9
	Oct. 9	14.8	14.8
	Nov. 20	14.4	12.6
M4.5	Jan. 22	11.6	10.1
	Mar. 25	11.9	10.9
	Apr. 1	10.7	9.6
	.....	....	....
	.....	....	....
.....	.....	....	....
	.....	....	....
	.....	....	....

Degree of maturation at harvest	Date sampled	Average pressure in pounds	
		Check	Treated
Golden Delicious			
	Sept. 11	16.8	16.3
	Oct. 23	16.0	15.7
M1.0	Dec. 11	13.3	12.1
	Feb. 12	12.4	11.8
	Feb. 19	12.6	12.6
	Sept. 18	18.5	17.2
	Oct. 30	14.7	13.4
M2.0	Dec. 11	13.4	12.6
	Feb. 12	11.3	11.1
	Feb. 19	12.6	12.6
	Sept. 25	15.7	16.4
	Nov. 6	14.2	13.8
M3.0	Dec. 11	13.6	13.2
	Feb. 12	11.6	11.4
	Feb. 19	12.0	11.6
	Oct. 2	16.6	15.5
	Nov. 13	12.6	11.3
M3.5	Dec. 11	11.6	12.9
	Feb. 12	12.7	11.8
	Feb. 19	11.1	10.2
	Oct. 9	14.7	11.9
	Nov. 20	13.9	10.4
M4.0	Dec. 11	13.2	10.5
	Feb. 12	13.2	9.8
	Feb. 19	8.1	11.8
	Oct. 16	13.7	10.0
	Nov. 27	12.0	9.6
M4.5	Dec. 11	11.3	9.1
	Feb. 12	11.3	9.0
	Feb. 19	11.3	9.1

[a, b] For footnotes, see Table 1, page 12.

caused abnormally high readings before the plunger broke through the flesh. This should demonstrate that data gathered by using the pressure tester as a texture-measuring device can be quite misleading.

Composition of the juice

The changes that occurred during ripening in the soluble solids and acidity of the expressed juice are shown in Tables 3, 4, and 5.

Soluble solids percentage. The differences between Jonathan check and treated samples (Table 3) and between Starking check and treated samples (Table 4) in the percentage of soluble solids were considered unimportant. In no sample group of either of these varieties was there any consistent change in the relationship between check and treated samples during ripening.

The difference between Golden Delicious check and treated samples in the percentage of soluble solids (Table 5) was not of enough magnitude to be of any significance to the consumer, even though the check samples were consistently higher, with the greatest differences being in the mature sample group picked October 9. Both check and treated

Table 3. — Effect of 2,4,5-TP Upon the Composition of Expressed Juice During Ripening of Jonathan, 1951 Crop

Date picked and degree of maturation at harvest	Date sampled	Percent of soluble solids		Percent of malic acid		pH		Ratio of soluble solids to acid	
		Check	Treated	Check	Treated	Check	Treated	Check	Treated
Sept. 11[a]. .	Sept. 11	12.6	12.8	.85	.83	3.30	3.30	14.82	15.42
	Oct. 23	13.2	13.3	.83	.81	3.30	3.30	15.90	16.42
M1.0	Jan. 15	13.7	13.7	.75	.75	3.41	3.42	18.27	18.27
	Mar. 4	13.5	13.6	.62	.63	3.46	3.44	21.77	21.59
	Mar. 11	13.4	13.4	.43	.43	3.51	3.53	31.16	31.16
Sept. 18. . .	Sept. 18	13.0	12.3	.85	.82	3.31	3.32	15.29	15.00
	Oct. 30	13.7	13.2	.83	.80	3.30	3.33	16.51	16.50
M2.0	Jan. 15	13.4	13.1	.73	.69	3.44	3.46	18.36	18.99
	Mar. 4	13.9	13.0	.62	.60	3.45	3.47	22.42	21.67
	Mar. 11	13.4	12.7	.43	.45	3.59	3.60	31.16	28.22
Sept. 25. . .	Sept. 25	13.6	13.1	.78	.75	3.30	3.30	17.44	17.47
	Nov. 6	13.7	14.1	.75	.73	3.33	3.30	18.27	19.32
M3.0	Jan. 15	13.5	13.7	.70	.71	3.47	3.48	19.29	19.30
	Mar. 4	13.3	13.4	.56	.57	3.49	3.51	23.75	23.51
	Mar. 11	13.6	14.3	.42	.43	3.62	3.62	32.38	33.26
Oct. 2.	Oct. 2	13.4	13.1	.67	.61	3.34	3.36	20.00	21.48
	Nov. 13	13.8	13.5	.60	.56	3.40	3.42	23.00	24.11
M4.0	Jan. 15	13.0	13.2	.65	.60	3.53	3.50	20.00	22.00
	Mar. 4	13.4	13.4	.44	.43	3.51	3.56	30.45	31.16
	Mar. 11	13.9	13.2	.41	.40	3.61	3.65	33.90	33.00
Oct. 9.	Oct. 9	13.2	12.8	.59	.57	3.41	3.44	22.37	22.46
	Nov. 20	13.7	13.3	.57	.54	3.42	3.47	24.04	24.63
M4.5	Jan. 15	13.5	13.0	.58	.58	3.56	3.55	23.28	22.41
	Mar. 4	13.2	12.6	.45	.45	3.54	3.59	29.33	28.00
	Mar. 11	13.6	13.4	.33	.32	3.70	3.72	41.21	41.88

[a] See footnote *a* to Table 1, page 12.

fruits in most of the Golden Delicious sample groups tasted sweeter as ripening progressed, but this could be as readily attributed to the consistent decrease in acid content as to increase in soluble solids.

Acid percentage. It is obvious that the differences between check and treated Jonathan samples in the percentage of acid (Table 3) fell within the range of experimental error. The decrease in the percentage of acid in each sample group as ripening progressed is usual for Jonathan.[9]

In Starking there was also no important difference between check and treated samples in acid percentage (see Table 4). Here again the decrease in the percentage of acid in each sample group during ripening followed the usual pattern.

The acid percentage of the Golden Delicious check samples was in almost every case higher than that of the treated samples (see Table 5). The differences that are significant occurred in all samples of the mature fruits picked October 9 and in those samples of the post-mature fruits picked on October 16 and sampled on October 16 and November 27. However, the values for the treated fruits in these samples are not unusually low for Golden Delicious picked at these stages of

Table 4. — Effect of 2,4,5-TP Upon the Composition of Expressed Juice During Ripening of Starking, 1951 Crop

Date picked and degree of maturation at harvest	Date sampled	Percent of soluble solids		Percent of malic acid		pH		Ratio of soluble solids to acid	
		Check	Treated	Check	Treated	Check	Treated	Check	Treated
Sept. 11[a]. .	Sept. 11	10.5	10.4	.28	.30	3.80	3.80	37.50	34.67
	Oct. 23	12.0	11.8	.26	.28	3.84	3.82	46.15	42.14
M1.0	Jan. 22	12.9	12.9	.26	.27	3.99	3.97	49.62	47.78
	Mar. 25	12.9	12.8	.18	.17	4.08	4.10	71.67	75.29
	Apr. 1	13.3	13.1	.14	.13	4.28	4.30	95.00	100.77
Sept. 18. . .	Sept. 18	11.2	10.8	.32	.30	3.95	4.00	35.00	36.00
	Oct. 30	12.7	12.1	.30	.28	3.92	3.88	42.33	43.21
M2.0	Jan. 22	13.0	13.0	.28	.28	4.02	3.99	46.43	46.43
	Mar. 25	13.4	12.5	.17	.15	4.11	4.17	78.82	88.33
	Apr. 1	13.4	13.4	.14	.14	4.31	4.27	95.71	95.71
Sept. 25. . .	Sept. 25	12.5	12.1	.32	.30	3.96	3.95	39.06	40.33
	Nov. 6	13.3	12.7	.30	.29	3.86	3.88	44.33	43.79
M3.0	Jan. 22	13.6	13.0	.25	.26	4.06	4.05	54.40	50.00
	Mar. 25	13.5	13.1	.18	.16	4.23	4.23	75.00	81.88
	Apr. 1	13.2	13.4	.13	.11	4.38	4.45	101.54	121.82
Oct. 2.	Oct. 2	12.6	12.7	.21	.19	3.96	3.98	60.00	66.84
	Nov. 13	13.2	13.2	.19	.16	3.95	3.97	69.47	82.50
M4.0	Jan. 22	13.6	13.4	.24	.21	4.15	4.20	56.67	63.81
	Mar. 25	13.4	12.9	.16	.12	4.26	4.40	83.75	107.50
	Apr. 1	13.4	13.2	.12	.10	4.47	4.45	111.67	132.00
Oct. 9.	Oct. 9	13.4	13.1	.28	.27	4.00	4.00	47.86	48.52
	Nov. 20	13.9	13.4	.26	.25	4.03	4.13	53.46	53.60
M4.5	Jan. 22	14.1	13.7	.23	.20	4.18	4.27	61.30	68.50
	Mar. 25	13.9	13.3	.15	.11	4.34	4.49	92.67	120.91
	Apr. 1	13.9	14.0	.10	.09	4.51	4.52	139.00	155.56

[a] See footnote *a* to Table 1, page 12.

maturation, and were probably an unimportant factor among those that contributed to their lower quality.

Hydrogen-ion concentration. The differences in pH between check and treated samples of all three varieties followed the same trend as that of acid percentage, which shows that pH and acid percentage were roughly correlated.

Soluble solids-acid ratio. In Jonathan there was no difference of any consequence between check and treated samples in the ratio of soluble solids to acid (see Table 3). In each sample group the ratio rose during the ripening period, owing primarily to decreasing acidity. For this reason, a high soluble solids-acid ratio in ripe or ripening Jonathans is not necessarily associated with high quality, as is often the case during maturation, but, instead, may be associated with decreasing quality, as it was in the last sample of each Jonathan sample group.

In Starking there was no large difference between check and

Table 5. — Effect of 2,4,5-TP Upon the Composition of Expressed Juice During Ripening of Golden Delicious, 1951 Crop

Date picked and degree of maturation at harvest	Date sampled	Percent of soluble solids		Percent of malic acid		pH		Ratio of soluble solids to acid	
		Check	Treated	Check	Treated	Check	Treated	Check	Treated
Sept. 11[a]...	Sept. 11	12.4	12.4	.56	.58	3.38	3.35	22.14	21.38
	Oct. 23	13.5	13.5	.52	.50	3.44	3.48	25.96	26.80
M1.0	Dec. 11	14.6	14.4	.32	.31	3.51	3.54	45.63	46.45
	Feb. 12	15.0	15.2	.33	.34	3.72	3.70	45.45	44.71
	Feb. 19	14.7	15.0	.28	.27	3.83	3.85	52.50	55.56
Sept. 18...	Sept. 18	13.1	12.1	.59	.55	3.39	3.41	22.20	22.00
	Oct. 30	14.4	13.5	.56	.47	3.40	3.45	25.71	28.72
M2.0	Dec. 11	15.2	14.4	.37	.33	3.49	3.53	41.08	43.64
	Feb. 12	15.6	14.6	.35	.31	3.67	3.73	44.57	47.10
	Feb. 19	16.3	14.9	.32	.29	3.80	3.86	50.94	51.38
Sept. 25...	Sept. 25	14.3	14.0	.56	.55	3.40	3.43	25.54	25.45
	Nov. 6	15.2	14.9	.54	.53	3.43	3.44	28.15	28.11
M3.0	Dec. 11	16.5	15.9	.44	.34	3.47	3.52	37.50	46.76
	Feb. 12	16.0	15.2	.37	.33	3.66	3.66	43.24	46.06
	Feb. 19	17.0	16.0	.32	.28	3.79	3.82	53.13	57.14
Oct. 2.....	Oct. 2	15.2	15.0	.52	.49	3.40	3.45	29.23	30.61
	Nov. 13	16.2	16.1	.41	.41	3.49	3.53	39.51	39.27
M3.5	Dec. 11	16.8	16.6	.40	.38	3.55	3.60	42.00	43.68
	Feb. 12	17.1	16.3	.39	.35	3.68	3.74	43.85	46.57
	Feb. 19	17.1	16.3	.31	.26	3.87	3.91	55.16	62.69
Oct. 9.....	Oct. 9	16.9	16.1	.69	.55	3.32	3.47	24.49	29.27
	Nov. 20	17.5	15.8	.60	.33	3.33	3.69	29.17	47.88
M4.0	Dec. 11	17.2	15.9	.56	.28	3.41	3.70	30.71	56.79
	Feb. 12	18.2	16.3	.48	.29	3.60	3.93	37.92	56.21
	Feb. 19	18.8	16.2	.39	.23	3.76	4.15	48.21	70.43
Oct. 16....	Oct. 16	16.5	16.1	.66	.47	3.40	3.57	25.00	34.26
	Nov. 27	16.8	16.5	.44	.26	3.42	3.69	38.18	63.46
M4.5	Dec. 11	16.3	16.2	.33	.29	3.53	3.63	49.39	55.86
	Feb. 12	17.2	16.4	.31	.29	3.70	3.94	55.48	56.55
	Feb. 19	17.4	17.2	.27	.26	3.90	4.10	64.44	62.31

[a] See footnote *a* to Table 1, page 12.

Table 6. — Effect of 2,4,5-TP Upon Percentage of Sugars and Dry Matter During Ripening of Jonathan, 1951 Crop
(based on fresh weight)

Date picked and degree of maturation at harvest	Date sampled	Dextrose		Levulose		Sucrose		Total sugars		Dry matter	
		Check	Treated	Check	Treated	Check	Treated	Check	Treated	Check	Treated
Sept. 11[a]	Sept. 11	1.70	1.77	5.84	5.82	3.09	3.38	10.63	10.97	16.05	16.35
	Oct. 23	1.80	1.80	6.10	6.29	3.27	3.51	11.17	11.60	16.00	16.40
M1.0	Jan. 15	2.21	2.27	6.23	6.45	2.89	2.87	11.33	11.59	16.20	16.30
	Mar. 4	2.39	2.39	6.49	6.41	2.42	2.30	11.30	11.10	15.90	16.15
	Mar. 11	2.49	2.48	7.11	7.09	2.18	2.08	11.77	11.66	16.10	15.95
Sept. 18	Sept. 18	1.63	1.54	6.11	5.96	3.16	3.22	10.90	10.72	16.45	15.95
	Oct. 30	1.79	1.75	6.21	6.10	3.93	3.40	11.93	11.25	16.55	15.90
M2.0	Jan. 15	2.06	2.03	6.35	6.40	3.02	3.10	11.43	11.53	16.10	15.90
	Mar. 4	2.17	2.07	6.36	6.39	2.91	2.68	11.43	11.14	16.10	15.65
	Mar. 11	2.28	2.19	7.17	6.65	2.15	2.33	11.60	11.17	16.20	15.30
Sept. 25	Sept. 25	1.70	1.68	6.20	5.78	3.79	3.82	11.69	11.28	16.80	16.25
	Nov. 6	1.79	1.86	6.19	6.27	3.72	3.79	11.70	11.93	16.20	16.30
M3.0	Jan. 15	2.09	2.10	6.29	6.37	3.24	3.16	11.62	11.63	16.05	16.40
	Mar. 4	2.07	2.14	6.64	6.62	3.03	3.31	11.74	12.07	16.20	15.95
	Mar. 11	2.26	2.35	7.10	7.22	2.22	2.57	11.59	12.13	15.85	16.40
Oct. 2	Oct. 2	1.49	1.50	5.97	5.98	3.61	3.59	11.07	11.07	16.50	15.90
	Nov. 13	1.85	1.79	6.36	6.17	3.65	3.56	11.86	11.52	16.20	15.95
M4.0	Jan. 15	2.03	2.01	6.18	6.34	3.28	3.22	11.50	11.57	15.90	15.75
	Mar. 4	2.13	2.16	6.52	7.34	3.01	2.75	11.66	12.25	15.85	15.85
	Mar. 11	2.31	2.10	6.96	7.04	2.49	2.46	11.60	11.76	15.90	15.45
Oct. 9	Oct. 9	1.61	1.62	5.95	5.82	3.66	3.44	11.22	10.88	15.90	15.40
	Nov. 20	1.84	1.75	6.10	5.95	3.67	3.56	11.61	11.26	16.10	15.60
M4.5	Jan. 15	2.02	1.92	6.36	6.30	3.23	3.06	11.61	11.28	15.80	15.35
	Mar. 4	1.96	2.03	6.40	6.42	3.19	2.83	11.55	11.28	15.60	15.10
	Mar. 11	2.28	2.15	6.78	6.83	2.53	2.51	11.59	11.49	15.90	15.55

[a] See footnote *a* to Table 1, page 12.

treated samples in the soluble solids-acid ratio except in the samples picked September 25 and sampled April 1 and in those picked October 2 and October 9 and sampled on March 25 and April 1 (Table 4). At these sample dates, the ratios were much higher in the treated samples, but they are of no importance since in each case they were caused by a slightly lower acid content: because of the low acid percentages in these samples, slight differences in acidity made large differences in the ratios.

In Golden Delicious the differences in the soluble solids-acid ratio between check and treated fruits were not significant except in the sample group picked October 9 and in those samples picked October 16 and sampled November 27 (Table 5). The higher ratios of the treated samples on these sample dates were due to lower acidity. Since these samples were lower in quality than the check samples, it is evident that a high ratio in ripened apples is not necessarily correlated with high quality.

Composition of the flesh

Sugars. The changes during ripening in the percentages of fresh weight and in amount per fruit of the sugars are shown in Tables 6 to 11.

Jonathan. Table 6 shows that the differences between Jonathan check and treated samples in the percentage of each of the sugars were all within the range of experimental error. With minor exceptions, the percentages of dextrose and levulose increased continuously during the ripening of each sample group, as was the case in previous ripening studies with Jonathan.[9] The sucrose percentage, however, tended to increase in the first ripened sample of each sample group and to decrease consistently in all subsequent samples. The amount per fruit of each of the sugars followed the same trend as that of the percentage (Table 7).

Starking. The data on Starking in Table 8 show that there was no consistent difference between check and treated samples in the percentage of each of the sugars. The percentages of each sugar during ripening followed the same trends as those previously observed for ripening Starking samples picked at similar degrees of maturation.[9]

The amount per fruit of each of the sugars was not consistently different between check and treated samples (see Table 9). This was to be expected since both the percentages and the average weights per fruit were similar at each sample date.

Golden Delicious. In this variety the differences between check and treated samples in the percentages of each of the sugars were neither consistent nor great enough to be of importance (Table 10). The trends in the percentage of each of the sugars during the ripening

Table 7. — Effect of 2,4,5-TP Upon Amount of Sugars and Dry Matter During Ripening of Jonathan, 1951 Crop
(in grams per fruit)

Date picked and degree of maturation at harvest	Date sampled	Average weight per fruit (in grams)		Dextrose		Levulose		Sucrose		Total sugars		Dry matter	
		Check	Treated	Check	Treated	Check	Treated	Check	Treated	Check	Treated	Check	Treated
Sept. 11[a]	Sept. 11	142.80	140.57	2.43	2.49	8.34	8.18	4.41	4.75	15.18	15.42	22.92	22.98
	Oct. 23	140.52	138.15	2.53	2.49	8.57	8.69	4.60	4.85	15.70	16.03	22.48	22.66
M1.0	Jan. 15	137.79	135.65	3.05	3.08	8.58	8.75	3.98	3.89	15.61	15.72	22.32	22.11
	Mar. 4	136.26	134.13	3.26	3.21	8.84	8.60	3.30	3.08	15.40	14.89	21.67	21.66
	Mar. 11	133.23	131.42	3.30	3.27	9.47	9.32	2.90	2.73	15.68	15.32	21.45	20.96
Sept. 18	Sept. 18	155.88	161.21	2.54	2.48	9.52	9.61	4.93	5.19	16.99	17.28	25.64	25.71
	Oct. 30	154.24	159.40	2.76	2.79	9.58	9.72	6.06	5.42	18.40	17.93	25.53	25.34
M2.0	Jan. 15	151.48	156.24	3.12	3.17	9.62	10.00	4.57	4.84	17.31	18.01	24.39	24.84
	Mar. 4	149.74	154.76	3.25	3.20	9.52	9.89	4.36	4.15	17.12	17.24	24.11	24.22
	Mar. 11	146.00	151.04	3.33	3.31	10.47	10.04	3.14	3.52	16.94	16.87	23.65	23.11
Sept. 25	Sept. 25	161.32	166.72	2.74	2.80	10.00	9.64	6.11	6.37	18.86	18.81	27.10	27.09
	Nov. 6	158.90	164.09	2.84	3.05	9.84	10.29	5.91	6.22	18.59	19.58	25.74	26.75
M3.0	Jan. 15	156.72	161.57	3.28	3.39	9.86	10.29	5.08	5.11	18.21	18.79	25.15	26.50
	Mar. 4	155.80	160.13	3.23	3.43	10.35	10.60	4.72	5.30	18.29	19.33	24.85	25.94
	Mar. 11	151.87	154.62	3.43	3.63	10.78	11.16	3.37	3.97	17.59	18.76	24.07	25.36
Oct. 2	Oct. 2	166.39	160.52	2.48	2.41	9.93	9.60	6.01	5.76	18.42	17.77	27.45	25.52
	Nov. 13	164.66	158.24	3.05	2.83	10.47	9.76	6.01	5.63	19.53	18.23	26.67	25.24
M4.0	Jan. 15	161.86	155.93	3.29	3.13	10.00	9.89	5.31	5.02	18.61	18.04	25.74	24.56
	Mar. 4	160.32	154.40	3.41	3.34	10.45	11.33	4.83	4.25	18.69	18.91	25.41	24.47
	Mar. 11	155.04	149.62	3.58	3.14	10.79	10.53	3.86	3.68	18.23	17.36	24.65	23.12
Oct. 9	Oct. 9	164.07	168.30	2.64	2.73	9.76	9.80	6.00	5.79	18.41	18.31	26.09	25.92
	Nov. 20	161.66	165.73	2.97	2.90	9.86	9.86	5.93	5.90	18.77	18.66	26.03	25.85
M4.5	Jan. 15	159.00	163.17	3.21	3.13	10.11	10.28	5.14	4.99	18.46	18.41	25.12	25.05
	Mar. 4	157.64	161.38	3.09	3.28	10.09	10.36	5.03	4.57	18.21	18.20	24.59	24.37
	Mar. 11	152.59	155.07	3.48	3.33	10.35	10.59	3.86	3.89	17.69	17.82	24.26	24.11

[a] See footnote *a* to Table 1, page 12.

Table 8. — Effect of 2,4,5-TP Upon Percentage of Sugars and Dry Matter During Ripening of Starking, 1951 Crop
(based on fresh weight)

Date picked and degree of maturation at harvest	Date sampled	Dextrose		Levulose		Sucrose		Total sugars		Dry matter	
		Check	Treated	Check	Treated	Check	Treated	Check	Treated	Check	Treated
Sept. 11[a]	Sept. 11	1.42	1.44	5.72	5.53	1.73	1.78	8.87	8.74	15.80	15.60
	Oct. 23	1.85	1.72	6.18	5.99	2.90	2.67	10.93	10.37	15.85	15.60
M1.0	Jan. 22	2.57	2.54	6.80	6.62	2.66	2.62	12.03	11.78	15.75	15.75
	Mar. 25	2.68	2.76	7.43	7.46	1.67	1.47	11.78	11.69	15.60	15.45
	Apr. 1	2.78	2.87	7.67	7.67	1.35	1.34	11.80	11.89	15.80	15.70
Sept. 18	Sept. 18	1.39	1.42	5.86	5.67	2.39	2.30	9.64	9.39	16.20	15.40
	Oct. 30	2.03	1.71	6.40	5.80	2.57	2.96	11.00	10.47	15.90	15.20
M2.0	Jan. 22	2.51	2.49	6.81	6.79	2.51	2.53	11.83	11.81	15.80	15.45
	Mar. 25	2.82	2.58	7.13	7.44	2.05	1.65	11.99	11.67	15.95	15.45
	Apr. 1	2.78	2.63	7.89	7.56	1.44	1.68	12.11	11.86	16.00	15.70
Sept. 25	Sept. 25	1.51	1.54	5.90	5.80	3.19	3.24	10.60	10.58	16.80	16.25
	Nov. 6	1.80	1.90	6.32	6.06	3.48	3.18	11.60	11.14	16.45	15.40
M3.0	Jan. 22	2.44	2.45	6.83	6.66	2.90	2.68	12.17	11.79	16.30	15.45
	Mar. 25	3.02	2.64	6.79	7.28	2.74	2.17	12.55	12.09	16.25	15.75
	Apr. 1	2.64	2.55	7.26	7.38	2.36	2.42	12.26	12.35	16.00	15.90
Oct. 2	Oct. 2	1.77	1.63	6.04	6.16	3.51	3.74	11.32	11.53	16.40	15.75
	Nov. 13	1.78	1.97	6.31	5.97	3.77	4.06	11.86	12.00	16.20	15.70
M4.0	Jan. 22	2.43	2.55	6.77	7.01	2.96	2.42	12.16	11.98	15.95	15.65
	Mar. 25	2.66	2.71	7.26	7.29	2.27	2.11	12.19	12.11	15.90	15.55
	Apr. 1	2.64	2.68	7.66	7.30	2.17	2.01	12.47	11.99	16.00	15.40
Oct. 9	Oct. 9	1.64	1.65	5.92	5.84	3.78	3.83	11.34	11.32	16.95	16.30
	Nov. 20	1.99	2.01	6.34	6.02	3.73	3.62	12.06	11.65	16.70	15.70
M4.5	Jan. 22	2.44	2.44	7.09	7.08	3.37	2.90	12.90	12.42	16.50	15.85
	Mar. 25	2.64	2.74	7.15	7.01	2.88	2.71	12.67	12.46	16.60	16.10
	Apr. 1	2.70	2.74	7.32	7.56	2.63	2.41	12.65	12.71	16.55	16.35

[a] See footnote *a* to Table 1, page 12.

of each of the sample groups were similar to those observed in previous investigations of ripening in Golden Delicious.[9] The fact that with one exception the highest total sugar percentage occurred in the last sample (the February 19 sample) of each sample group shows that sugar content alone is not a reliable criterion of quality, since these samples were definitely inferior in quality to the preceding samples — those of February 12. Furthermore the sugar percentages were not correlated with the differences in quality between Golden Delicious check and treated samples (see page 11).

The amount of each of the sugars per fruit was usually higher in the check samples than in the treated samples (Table 11). These differences were not important because in most cases they were caused by a higher average weight per fruit in the check samples.

Dry matter. The changes in the percentages of dry matter during ripening are shown in Tables 6, 8, and 10; the changes in amount per fruit in Tables 7, 9, and 11.

The check fruits of all three varieties usually showed higher percentages of dry matter than the treated fruits. Differences, however, were not great enough to be important except between the check and treated samples of the mature Golden Delicious sample group picked October 9. It is of interest that the severer shrivel shown by treated Golden Delicious (Table 1) was not associated with higher percentages of dry matter, as would have been the case had shrivel been caused by moisture loss alone.

The data on amount of dry matter per fruit show that during ripening there was a continuous decrease in each sample group of each variety, with no significant difference between check and treated samples.

Weight loss

The differences between check and treated samples in average daily weight loss (Table 12) were not significant except in the Jonathan and Starking samples picked October 9 and kept for an additional 7 days at 75° F., and in the Golden Delicious samples picked October 2, October 9, and October 16 that were likewise kept at that temperature. The greater rate of weight loss in the treated fruits of these samples emphasizes the catabolic potentialities of 2,4,5-TP.

It should be noted that the Golden Delicious samples in each sample group maintained a higher rate of weight loss than Jonathan and Starking samples picked at similar stages of maturation. Another noteworthy fact (shown in Table 12) is that the rate of weight loss in each of the samples ripened for 7 days at 75° F. was several times as great as that of those samples in the same group which were not so ripened. This emphasizes that if high quality is to be maintained, apples must be kept in low-temperature storage until consumed.

Table 9. — Effect of 2,4,5-TP Upon Amount of Sugars and Dry Matter During Ripening of Starking, 1951 Crop
(in grams per fruit)

Date picked and degree of maturation at harvest	Date sampled	Average weight per fruit (in grams)		Dextrose		Levulose		Sucrose		Total sugars		Dry matter	
		Check	Treated	Check	Treated	Check	Treated	Check	Treated	Check	Treated	Check	Treated
Sept. 11[a]	Sept. 11	150.42	158.22	2.13	2.28	8.60	8.75	2.60	2.82	13.34	13.83	23.77	24.68
	Oct. 23	148.49	156.56	2.75	2.69	9.18	9.38	4.31	4.18	16.23	16.24	23.54	24.42
M1.0	Jan. 22	144.91	152.94	3.72	3.88	9.85	10.12	3.85	4.01	17.43	18.02	22.82	24.09
	Mar. 25	143.23	150.39	3.84	4.15	10.64	11.22	2.39	2.21	16.87	17.58	22.34	23.24
	Apr. 1	139.45	146.89	3.88	4.22	10.70	11.27	1.88	1.97	16.46	17.47	22.03	23.06
Sept. 18	Sept. 18	181.21	169.59	2.52	2.41	10.62	9.62	4.33	3.90	17.47	15.92	29.36	26.12
	Oct. 30	178.93	167.08	3.63	2.86	11.45	9.69	4.60	4.95	19.68	17.49	28.45	25.40
M2.0	Jan. 22	175.54	163.04	4.41	4.06	11.95	11.07	4.41	4.12	20.77	19.26	27.74	25.19
	Mar. 25	173.11	161.86	4.88	4.18	12.34	12.04	3.55	2.67	20.76	18.89	27.61	25.01
	Apr. 1	167.96	157.07	4.67	4.13	13.25	11.87	2.42	2.64	20.34	18.63	26.87	24.66
Sept. 25	Sept. 25	189.19	184.66	2.86	2.84	11.16	10.71	6.04	5.98	20.05	19.54	31.78	30.01
	Nov. 6	185.61	182.09	3.34	3.46	11.73	11.03	6.46	5.79	21.53	20.28	30.53	28.04
M3.0	Jan. 22	183.76	181.50	4.48	4.45	12.55	12.09	5.33	4.86	22.36	21.40	29.95	28.04
	Mar. 25	180.13	177.24	5.44	4.68	12.23	12.90	4.94	3.85	22.61	21.43	29.27	27.92
	Apr. 1	177.65	172.44	4.69	4.40	12.90	12.73	4.19	4.17	21.78	21.30	28.42	27.42
Oct. 2	Oct. 2	184.96	183.89	3.27	3.00	11.17	11.33	6.49	6.88	20.94	21.20	30.33	28.96
	Nov. 13	183.17	182.22	3.26	3.59	11.56	10.88	6.91	7.40	21.72	21.87	29.67	28.61
M4.0	Jan. 22	181.32	179.31	4.41	4.57	12.28	12.57	5.37	4.34	22.05	21.48	28.92	28.06
	Mar. 25	178.02	175.61	4.74	4.76	12.92	12.80	4.04	3.71	21.70	21.27	28.31	27.31
	Apr. 1	173.01	169.86	4.57	4.55	13.25	12.40	3.75	3.41	21.57	20.37	27.68	26.16
Oct. 9	Oct. 9	202.89	204.49	3.33	3.37	12.01	11.94	7.67	7.83	23.01	23.15	34.39	33.33
	Nov. 20	200.13	202.18	3.98	4.06	12.69	12.17	7.46	7.32	24.14	23.55	33.42	31.74
M4.5	Jan. 22	197.19	198.60	4.81	4.85	13.98	14.06	6.65	5.76	25.44	24.67	32.54	31.48
	Mar. 25	193.54	194.39	5.11	5.33	13.84	13.63	5.57	5.27	24.52	24.22	32.13	31.30
	Apr. 1	188.26	185.94	5.08	5.09	13.78	14.06	4.95	4.48	23.81	23.63	31.16	30.40

[a] See footnote *a* to Table 1, page 12.

Table 10. — Effect of 2,4,5-TP Upon the Percentage of Sugars and Dry Matter During Ripening of Golden Delicious, 1951 Crop

(based on fresh weight)

Date picked and degree of maturation at harvest	Date sampled	Dextrose		Levulose		Sucrose		Total sugars		Dry matter	
		Check	Treated	Check	Treated	Check	Treated	Check	Treated	Check	Treated
Sept. 11[a]	Sept. 11	1.13	1.18	6.18	6.09	3.17	3.19	10.48	10.46	16.80	16.65
	Oct. 23	1.47	1.53	6.56	6.34	3.72	3.92	11.75	11.78	16.85	16.70
M1.0	Dec. 11	1.74	1.89	6.90	6.64	3.86	3.76	12.51	12.28	17.30	17.00
	Feb. 12	2.08	2.14	7.62	7.22	3.25	3.53	12.95	12.90	17.55	17.30
	Feb. 19	1.91	1.97	8.11	7.83	3.36	3.41	13.37	13.21	17.50	17.30
Sept. 18	Sept. 18	1.20	1.26	6.52	6.20	3.67	3.44	11.39	10.90	17.75	16.45
	Oct. 30	1.50	1.60	6.90	6.30	4.15	4.22	12.55	12.12	18.00	16.60
M2.0	Dec. 11	1.76	1.81	7.07	6.72	4.33	3.95	13.17	12.48	18.25	16.80
	Feb. 12	2.16	1.79	8.02	7.30	3.71	3.49	13.89	12.58	18.60	17.10
	Feb. 19	1.83	1.97	8.55	7.60	3.90	3.62	14.28	13.19	19.10	17.30
Sept. 25	Sept. 25	1.24	1.20	7.01	6.46	4.72	4.71	12.97	12.37	18.40	17.85
	Nov. 6	1.55	1.37	7.35	6.78	4.56	4.79	13.46	12.94	18.65	18.00
M3.0	Dec. 11	1.54	1.67	7.36	6.68	4.78	4.87	13.68	13.22	19.05	18.15
	Feb. 12	2.04	1.89	8.01	7.63	4.32	4.14	14.36	13.66	19.25	18.35
	Feb. 19	1.98	1.90	8.53	8.07	4.69	4.32	15.20	14.29	19.75	18.55
Oct. 2	Oct. 2	1.34	1.32	7.31	6.81	4.85	5.23	13.50	13.36	18.75	18.35
	Nov. 13	1.39	1.32	7.39	6.93	5.40	5.59	14.18	13.84	18.80	18.40
M3.5	Dec. 11	1.68	1.60	7.05	6.54	5.12	5.27	13.85	13.41	18.75	18.20
	Feb. 12	1.97	1.91	7.45	7.15	4.98	4.93	14.39	14.00	19.05	18.55
	Feb. 19	1.98	1.98	8.50	7.83	4.40	4.56	14.88	14.37	19.30	18.45
Oct. 9	Oct. 9	1.49	1.27	6.95	6.83	5.56	5.60	14.00	13.70	20.55	18.85
	Nov. 20	1.70	1.41	7.14	6.85	6.15	5.78	14.99	14.04	20.40	18.45
M4.0	Dec. 11	1.91	1.70	7.09	6.91	5.65	5.49	14.65	14.10	20.15	18.50
	Feb. 12	2.20	1.93	7.79	7.42	5.15	4.80	15.14	14.15	20.45	18.70
	Feb. 19	2.27	1.90	8.59	7.75	4.58	4.31	15.45	13.96	20.75	18.15
Oct. 16	Oct. 16	1.41	1.44	7.13	7.00	6.39	5.46	14.94	13.90	19.65	18.85
	Nov. 27	1.66	1.44	6.97	7.00	5.92	6.09	14.55	14.53	19.90	18.85
M4.5	Dec. 11	1.56	1.50	7.57	6.92	6.02	5.92	15.15	14.34	19.35	18.60
	Feb. 12	1.78	1.80	8.19	7.45	4.57	5.06	14.76	14.32	19.45	18.70
	Feb. 19	2.13	2.03	8.51	8.11	4.59	4.73	15.23	14.87	19.80	19.35

[a] See footnote *a* to Table 1, page 12.

EVALUATION OF RESULTS

Whether a practice should be introduced into fruit production depends primarily upon how that practice affects fruit quality both during maturation and ripening. Quality is the paramount consideration, for consumers prefer high-quality fruits and economic returns are directly related to the degree of quality of the fruits offered for sale.

For this reason 2,4,5-TP as a preharvest spray on apples is here evaluated on the basis of its effects upon quality during ripening. (Its effects upon maturation were reported in two previous bulletins.[10, 11]) The effect of 2,4,5-TP upon condition during ripening is also considered here, because the spray affected the condition of some of the samples of each variety.

Effects on quality and condition during ripening are best measured at the time when samples — check and treated alike — reach maximum quality (ripeness). For commercial purposes, this stage can by experience be estimated with sufficient accuracy.

Effects of 2,4,5-TP on Apples Harvested When Immature

This report shows that no difference in quality between check and treated fruits can be expected during ripening when these three varieties are harvested at an immature stage. The only exception to this was the Golden Delicious sample group picked October 2 in which check fruits ripened to higher quality than the treated fruits. This treated sample group, being near to maturity at harvest, showed the deleterious effect of 2,4,5-TP upon quality. The fact that the ripened check fruits in the October 2 picking of Golden Delicious had higher quality than the treated fruits strongly indicates that any effect 2,4,5-TP might have upon the quality of ripening apples would be deleterious.

In any case, it is doubtful that any "growth-affecting" substance applied to apples before harvest will cause immature fruits to reach during ripening a degree of quality anywhere near that attained by untreated apples picked at maturity.

As to condition, the data failed to show any specific difference between check and treated fruits in any of the immature sample groups, except for the Golden Delicious sample group picked October 2. In this group the treated fruits had a higher percentage of severe shrivel than the check fruits (Table 1). It seems probable that if earlier applications of 2,4,5-TP had been made, the treated samples in the immature sample groups would have had even poorer condition during ripening.

Table 11.—Effect of 2,4,5-TP Upon Amount of Sugars and Dry Matter During Ripening of Golden Delicious, 1951 Crop

(in grams per fruit)

Date picked and degree of maturation at harvest	Date sampled	Average weight per fruit (in grams)		Dextrose		Levulose		Sucrose		Total sugars		Dry matter	
		Check	Treated	Check	Treated	Check	Treated	Check	Treated	Check	Treated	Check	Treated
Sept. 11[a].....	Sept. 11	158.83	161.08	1.79	1.90	9.82	9.81	5.03	5.14	16.65	16.85	26.68	26.82
	Oct. 23	154.18	156.62	2.27	2.40	10.11	9.93	5.74	6.14	18.12	18.45	25.98	26.16
M1.0	Dec. 11	149.86	152.17	2.61	2.88	10.34	10.34	5.78	5.72	18.75	18.69	25.93	25.87
	Feb. 12	145.74	148.31	3.03	3.17	11.11	10.71	4.74	5.24	18.87	19.13	25.58	25.66
	Feb. 19	141.39	143.25	2.70	2.82	11.47	11.22	4.75	4.88	18.90	18.92	24.74	24.78
Sept. 18.....	Sept. 18	169.79	166.49	2.04	2.10	11.07	10.32	6.23	5.73	19.34	18.15	30.14	27.39
	Oct. 30	165.27	161.55	2.48	2.58	11.40	10.18	6.86	6.82	20.74	19.58	29.75	26.82
M2.0	Dec. 11	161.10	157.42	2.84	2.85	11.39	10.58	6.98	6.22	21.22	19.65	29.40	26.45
	Feb. 12	155.95	152.44	3.37	2.73	12.51	11.13	5.79	5.32	21.66	19.18	29.01	26.07
	Feb. 19	150.54	147.99	2.75	2.92	12.87	11.25	5.87	5.36	21.50	19.52	28.75	25.60
Sept. 25.....	Sept. 25	174.40	169.79	2.16	2.04	12.23	10.97	8.23	8.00	22.62	21.00	32.09	30.31
	Nov. 6	169.27	164.98	2.62	2.26	12.44	11.19	7.72	7.90	22.78	21.35	31.57	29.70
M3.0	Dec. 11	165.40	161.96	2.55	2.70	12.17	10.82	7.91	7.89	22.63	21.41	31.51	29.40
	Feb. 12	159.65	156.55	3.26	2.96	12.79	11.94	6.90	6.48	22.93	21.38	30.73	28.73
	Feb. 19	153.73	150.69	3.04	2.86	13.11	12.16	7.21	6.51	23.36	21.53	30.36	27.95
Oct. 2.....	Oct. 2	183.60	185.87	2.46	2.45	13.42	12.66	8.90	9.72	24.79	24.83	34.43	34.11
	Nov. 13	179.23	180.13	2.49	2.38	13.25	12.48	9.86	10.07	25.41	24.93	33.70	33.14
M3.5	Dec. 11	176.02	176.48	2.96	2.82	12.41	11.54	9.01	9.30	24.38	23.67	33.00	32.12
	Feb. 12	170.00	170.00	3.35	3.25	12.67	12.16	8.47	8.38	24.46	23.80	32.39	31.54
	Feb. 19	165.30	162.60	3.27	3.22	14.05	12.73	7.27	7.41	24.60	23.37	31.90	30.00
Oct. 9.....	Oct. 9	185.57	188.98	2.76	2.40	12.90	12.91	10.32	10.58	25.98	25.89	38.13	35.62
	Nov. 20	180.54	182.46	3.07	2.57	12.89	12.50	11.10	10.55	27.06	25.62	36.83	33.66
M4.0	Dec. 11	177.85	179.61	3.40	3.05	12.61	12.41	10.05	9.86	26.06	25.33	35.84	33.23
	Feb. 12	171.08	171.05	3.76	3.30	13.33	12.69	8.81	8.21	25.90	24.20	34.99	31.99
	Feb. 19	163.47	163.77	3.71	3.11	14.04	12.69	7.49	7.06	25.25	22.86	33.91	29.72
Oct. 16.....	Oct. 16	186.44	189.78	2.63	2.73	13.29	13.28	11.91	10.36	27.85	26.38	36.64	35.77
	Nov. 27	181.31	181.90	3.01	2.62	12.64	12.73	10.73	11.08	26.38	26.43	36.08	34.29
M4.5	Dec. 11	178.85	178.66	2.79	2.68	13.54	12.36	10.77	10.58	27.10	25.62	34.61	33.23
	Feb. 12	172.20	170.06	3.44	3.06	14.10	12.67	7.87	8.61	25.42	24.35	33.49	31.80
	Feb. 19	164.92	159.26	3.51	3.23	14.03	12.92	7.57	7.53	25.12	23.68	32.65	30.82

[a] See footnote *a* to Table 1, page 12.

Effects of 2,4,5-TP on Apples Harvested at or Near Maturity

The lower quality of the treated fruits in the mature Jonathan and Starking sample groups persisted throughout ripening. This showed that no advantage can be gained from using 2,4,5-TP on these two varieties, unless drop cannot be controlled effectively and economically by any other material. The softer texture and deficient flavor that were characteristic of the mature treated Jonathans and Starkings at harvest still characterized these apples when they reached ripeness.

2,4,5-TP did not affect the condition of Jonathan and Starking, except that the treated Jonathan samples picked September 25, October 2, and October 9, and sampled March 4 and March 11 had a higher percentage of Jonathan spot than the check fruits. Though these samples were post-ripe and ordinarily would not have been held so long in storage, the data indicated that 2,4,5-TP has the potentiality of increasing the development of Jonathan spot.

Before considering the quality and condition of Golden Delicious in storage, it must first be pointed out that 2,4,5-TP caused a significant percentage of Golden Delicious apples to crack or become abnormally soft on the trees by the time they became mature or slightly post-mature, and that, in selecting mature and post-mature samples for ripening, these fruits were rejected. Such selection, of course eliminated the worst effect of 2,4,5-TP.

The treated Golden Delicious sample groups picked October 2, October 9, and October 16 became, in comparison with the corresponding check groups, increasingly lower in quality as the storage period lengthened. This showed that the disadvantages of the use of 2,4,5-TP on Golden Delicious are quite likely to outweigh the advantages, especially if the apples are to be stored for longer than a few weeks. This is particularly true of this variety, since Golden Delicious drop is easily controlled by NAA and the spray has no deleterious effect on quality or condition of the fruit.

Effects of 2,4,5-TP on Apples Post-Ripened at 75° F.

Although the quality of the check and treated samples of all three varieties deteriorated rapidly during the post-ripening interval of 7 days at 75° F., the treated samples of the mature and post-mature pickings, especially those of Golden Delicious, showed a more rapid deterioration in quality than check samples. During this post-ripening period, there was little difference in quality between check and treated samples in the immature pickings, except that the treated fruits in the Golden Delicious sample group picked October 2 decreased in quality more rapidly than the check fruits.

Table 12. — Effect of 2,4,5-TP Upon Percentage of Daily Weight Loss in Jonathan, Starking, and Golden Delicious During Ripening, 1951 Crop

Date picked and degree of maturation at harvest	Date sampled	Days in storage	Average daily weight loss (in percent)	
			Check	Treated
Jonathan				
Sept. 11[a]	Oct. 23	42	.038	.041
	Jan. 15	126	.028	.028
M1.0	Mar. 4	175	.026	.026
	Mar. 11	182[b]	.313	.284
Sept. 18	Oct. 30	42	.025	.027
	Jan. 15	119	.024	.026
M2.0	Mar. 4	168	.023	.024
	Mar. 11	175[b]	.396	.329
Sept. 25	Nov. 6	42	.036	.038
	Jan. 15	112	.025	.028
M3.0	Mar. 4	161	.021	.025
	Mar. 11	168[b]	.356	.433
Oct. 2	Nov. 13	42	.025	.034
	Jan. 15	105	.026	.027
M4.0	Mar. 4	154	.024	.025
	Mar. 11	161[b]	.423	.453
Oct. 9	Nov. 20	42	.035	.036
	Jan. 15	98	.032	.031
M4.5	Mar. 4	147	.027	.028
	Mar. 11	154[b]	.417	.501
Starking				
Sept. 11[a]	Oct. 23	42	.030	.025
	Jan. 22	133	.028	.025
M1.0	Mar. 25	196	.024	.025
	Apr. 1	203[b]	.311	.347
Sept. 18	Oct. 30	42	.030	.035
	Jan. 22	126	.025	.031
M2.0	Mar. 25	189	.024	.024
	Apr. 1	196[b]	.399	.406
Sept. 25	Nov. 6	42	.045	.033
	Jan. 22	119	.024	.014
M3.0	Mar. 25	182	.026	.022
	Apr. 1	189[b]	.357	.384
Oct. 2	Nov. 13	42	.022	.032
	Jan. 22	112	.022	.025
M4.0	Mar. 25	175	.026	.026
	Apr. 1	182[b]	.377	.440
Oct. 9	Nov. 20	42	.032	.027
	Jan. 22	105	.027	.027
M4.5	Mar. 25	168	.027	.029
	Apr. 1	175[b]	.416	.594
Golden Delicious				
Sept. 11[a]	Oct. 23	42	.070	.067
	Dec. 11	91	.062	.061
M1.0	Feb. 12	154	.054	.051
	Feb. 19	161[b]	.419	.484
Sept. 18	Oct. 30	42	.063	.071
	Dec. 11	84	.061	.065
M2.0	Feb. 12	147	.055	.057
	Feb. 19	154[b]	.436	.369
Sept. 25	Nov. 6	42	.070	.067
	Dec. 11	77	.067	.060
M3.0	Feb. 12	140	.060	.056
	Feb. 19	147[b]	.450	.483
Oct. 2	Nov. 13	42	.057	.074
	Dec. 11	70	.059	.072
M3.5	Feb. 12	133	.056	.064
	Feb. 19	140[b]	.380	.533
Oct. 9	Nov. 20	42	.065	.082
	Dec. 11	63	.066	.079
M4.0	Feb. 12	126	.062	.075
	Feb. 19	133[b]	.613	.806
Oct. 16	Nov. 27	42	.065	.099
	Dec. 11	56	.073	.105
M4.5	Feb. 12	119	.064	.087
	Feb. 19	126[b]	.540	.790

[a] See footnote *a* to Table 1, page 12.
[b] Including a final 7-day interval at 75° F.; all other storage intervals were at 32° F. The average daily weight loss of this sample is shown only for those 7 days, whereas the average daily weight loss shown for all other samples was computed on the basis of their average weight at harvest.

CONCLUSIONS AND RECOMMENDATIONS

An increased rate of softening during maturation or ripening is one of the worst effects that can be obtained from a preharvest spray, because this effect is likely to be associated with deficient quality. The data of this bulletin and of the previous bulletin[11] show that 2,4,5-TP is apt to cause abnormal softening during both the maturation and ripening of Golden Delicious. Similar effects from 2,4,5-TP have also occurred in Grimes and Cortland grown in Illinois.[8] This indicates that under certain conditions 2,4,5-TP may cause similar deleterious effects on any of the fall-maturing varieties, although it is probable that the effect on the fall-maturing varieties will not be so severe as that which occurred in some summer-maturing varieties.[10] NAA at the recommended concentration of 10 p.p.m. is not likely to have any adverse effect upon either the maturation or ripening of fall-maturing varieties, even if multiple applications at this concentration are made. Probable exceptions to this are McIntosh and varieties similar to McIntosh in physiological makeup.

Two applications of 2,4,5-TP at concentrations of 10 p.p.m. are less likely to affect texture and quality than single or double applications at 20 p.p.m.[9] Variable results, however, are certain to be obtained at any concentration, and each grower, if he uses this material, will have to work out that practice which is most suitable to the physiological condition of his trees.

2,4,5-TP should in no sense be considered a substitute either for normal maturation or for those practices, such as pest control, proper fertilization, pruning, and thinning, that promote the production of mature apples of satisfactory size, color, texture, and flavor.

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Two other Illinois Agricultural Experiment Station Bulletins report investigations similar to the one reported here. These publications are:

Effect of Preharvest Sprays of 2,4,5-Trichlorophenoxypropionic Acid Upon the Maturation of Important Summer-Maturing Apple Varieties. Bulletin 588. By Richard V. Lott and Robert R. Rice. 32p. 1955.

Effect of Preharvest Sprays of 2,4,5-Trichlorophenoxypropionic Acid Upon the Maturation of Jonathan, Starking, and Golden Delicious Apples. Bulletin 589. By Richard V. Lott and Robert R. Rice. 30 p. 1955.

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